3

DISSERTATIONS UPON THE INGRAFTMENT OF THE *SMALL-POX*, According to the Method of TURKY.

AND

Upon other uſeful Topicks relating to the Animal Oeconomy, and in Particular, unto the State of our Fluids and Veſſels in Fevers.

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τὸ μὲν γάρ τι τῶν μὴ εὑρημένων ἐξευρίσκειν, ὅ, τι καὶ εὑρεθὲν κρέσσον ἢ ἀνεξεύρετον, ξυνέσιος δοκέει ἐπιθύμημά τε καὶ ἔργον εἶναι.

Hipp. περὶ τέχνης.

οὐδεὶς ἀγεωμέτρητος εἰσίτω. *Plato.*

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The Introduction.

IT ought to be no Surprize to us, that the Modes of Speaking ſhould vary according to the Philoſophy of the Age, and as Mathematicks and Mechanical Reaſoning have of late been introduced, and with juſt Grounds applied to the Animal Oeconomy, it becomes very neceſſary for us to borrow many Terms in *Phyſick* from *Geometry*. And from hence it has come to paſs, that Men of polite Literature, of *Belles Lettres*, and well skill'd in thoſe Arts, have with a good Grace contributed their *Quota*'s in an ample Manner from their teeming Stores. They have thereby detected many precarious Opinions, and confirm'd us that the Courſe they ſteer is well regulated. It cannot however be laid to their Charge, that they have abandoned the juſt Sentiments of that Sect, which has merited the Appellation of *Humoriſts*, nor do they deny them, whatever that Tribe could wiſh for. Becauſe we ſtill find that they acknowledge our Fluids to be *Phlegmatick* (a), *Aqueous* (b), *Tartareous*, which is but another Term for *Acid* (c), *Saline* (d), *Flatulent* (e), *Bilioſe* (f), *Fixt*, and *Volatile*, or *Active* (g), *Acrimonious* or *Corroſive* (h), *Rarefied*, *Agitated*, or *Fermented* (i), *Coagulated* or *Viſcid* (k), and *Solid*, *Earthy*, *Stony* or *Gritty* (l), as heretofore: But how nearly have they alſo adapted the *Laws of Motion*, to our circulating Fluid! So that from the joint Conſideration of thoſe *Qualities* and this *Quantity of Motion*, they have nearly modell'd Phyſick into a complete Science. Some few there are

(a) *Pitcairn* L. 1. C. 6. §. 10. (b) Id. ib. C. 5. §. 73. C. 6. §. 6. (c) Id. ib. C. 5. §. 74. L. 2. C. 18. §. 51. C. 22. §. 2. (d) Id, L. 1. C. 5. §. 73. C. 6. §. 14. (e) Id. L. 2. C. 22. §. 4. (f) Id. L. 1. C. 6. §. 10. (g) Id. ib. C. 6. §. 23. (h) *Bellin.* p. 263. §. 1. p. 281. lin. 29. p. 547. lin. 24. (i) *Pitc.* L. 1. C. 5. §. 77. C. 6. §. 6. *Bellin.* p. 281. lin. 25. p. 511. lin. 19. 20. (k) *Bellin.* p. 280. p. 353 ad p. 358. *Pitc.* L. 1. C. 5. §. 51. (l) *Pitc.* L. 1. C. 5. §. 73. 82. C. 6. §. 34. L. 2. C. 24. §. 6.

indeed, who contemn the *Humoriſts*, and altho' unskill'd in the Mechanicks, are yet ever and anon ſtrenuouſly making an Effort to cry up the latter in Oppoſition to the former: As if they made it a Merit to raiſe a Faction, and diſmember the One from the other: Being little aware, how willingly the *Humoriſts* embrace all ſuch Improvements, or how glad the *Mechaniſts* are of ſo ſolid a Foundation. How wretched an Affectation is it then in ſuch to brangle about Terms, or, what is yet worſe, to calumniate all Mankind with a Stock of ill Manners and Nature, and with a groundleſs Aſſurance to damn all thoſe, who fall not into their Meaſures! Is it worth the while, for Example, for Phyſicians, who are intent upon Things, and not Words, to diſpute and inſiſt upon it with main Force, whether the vicious Changes made, ſhall be called *Diſeaſes of the Qualities*, or *Diſeaſes of Velocity?* Surely as the former introduce the latter, the Sum Total of the

Queſtion is only, whether we ſhall denominate Diſeaſes from their Cauſes, or from their Effects. Strange Buffoonery! But, thank Heaven, ſuch is the Fate of theſe *Inſenſati*, that whilſt their poor Ambition furniſhes them with Noiſe, Aſſurance, and other endearing Qualifications; their Ignorance and Affectation render them ridiculous to all good and wiſe Men; and juſtly entitle them to *Agamemnon*'s *Scoff* upon *Achilles* (n).

If I have err'd in affirming, that *the Blood contains Fire*, becauſe it contains a *Phoſphorus*, and is luminous; I err with great Men in the preſent Age; as may be ſeen in Dr. '*sGraveſande*, *Vol.* 21. *on Fire*, &c. So that ſome ſcurrilous Perſons will have the diſpleaſure to obſerve, that the wiſe Mathematicians have not rejected Qualities in the Blood, but have always ſuppos'd them as given, and have founded their Reaſoning upon ſuch *Data*.

(n) Ἀλλ᾽ ὅδ᾽ ἀνὴρ ἐθέλει περὶ πάντων ἔμμεναι ἄλλων,
πάντων μὲν κρατέειν ἐθέλει, πάντεσσι δ᾽ ἀνάσσειν,
πᾶσι δὲ σημαίνειν, ἅτιν᾽ οὐ πείσεσθαι ὀΐω.

DISSERTATIONS Upon the INGRAFTMENT OF THE *SMALL-POX*, &c.

IT has often ſtruck me with Amazement, to ſee Mankind run blindly on in refuſing Obedience to their Senſes in Phyſical Matters; and to find ſome Phyſicians Zealots to a Sect of Philoſophy, which with Regard to their Buſineſs, may juſtly be reputed incomplete, and will be acknowledg'd by its Author, if demanded ed of him, foreign to what is not *menſurable*; It is however a Glory to our Nation, that we can boaſt of two great Men, each of whom has introduc'd a Way of Thinking, certain and demonſtrative; the firſt prov'd all he advanc'd by Experiments, and the latter by *Geometry*; the firſt conſider'd Things *Phyſically*, and the latter *Mechanically*; the firſt inquir'd into the Structures of Bodies, and the latter into the Laws of Motion; we are inabled by the Induſtry of the former to determine on the various States of Fluids, on the Powers of Nature, the Properties of natural Bodies, their mutual Actions upon one another, on Textures, Figures, *Effluvia* and other Modes of Bodies; and by the prodigious Diſcoveries of the latter, we are made Maſters of the Laws of Motion of Solids and Fluids; it was foreign to the Latter to conſider Things phyſically; that Work, he knew, was done before; and therefore he open'd a new Scene, which he begun and perfected.

Phyſicians then have Occaſion, both for the *Experimental* and the *Mechanical* Philoſophy: it is impoſſible for them to account for the Laws of Motion in our Fluids without the latter, or for the various States of *Them* without the former. A Mixture then of Philoſophies is abſolutely neceſſary in Phyſicians; for the Diſcovery of which, the World ſtands indebted to a *Boyle* and a *Newton*.

As there are ſeveral Experiments, which do not fall under Computation; ſo are there Computations, which have no Connexion with the

Experiments here ſpoken of; *Chymiſtry* is the Origin of the former, and *Geometry* of the latter; it is however certain, that Geometry and Mechanicks have added Light to all thoſe *Phænomena* in Chymiſtry, which depend upon the Laws of Motion; but yet it is too ſure we are at a Loſs to reduce all *that* Art under *this*. Some *Phænomena* indeed there are, which admit of *Menſuration*, and may alſo be accounted for *Phyſically*: for Example; An *Æquilibrium* in two communicating Cylinders is accounted for by Geometricians thus, becauſe the Baſes and Altitudes of equal Cylinders being reciprocally proportional, ſo much as the Baſe of one is greater than the other's, ſo much back again does the Height of this latter exceed the Height of the former; putting B and b for the Baſes, A and a, for the Altitudes; then will it ſtand thus $B : b :: A : a$, than $B a = b A$., and taking A, a, for the Squares of the Velocity, or $\sqrt{}^{2} : A$. for the Velocity, than $B a \times \sqrt{}^{2} : a$ (or v) $= b A \times \sqrt{}^{2} : A$, (or V); for $B a : b A :: \sqrt{}^{2} : A$ (or V) : $\sqrt{a}$ (or v) that is, ſo much as one Quantity $\sqrt{a}$ (or v) exceeds the other, ſo much does the Velocity of this exceed that, and therefore the Deſcent of the one equiponderates the Aſcent of the other: for as the Baſes and Altitudes are reciprocal; as the Velocities are directly as the Altitudes; as in equal Altitudes the Quantities are as the Baſes; and as the Velocities are reciprocal to the Quantities; therefore as the Moments are equal, but contrary, they deſtroy each other, and no Motion enſues: becauſe when two Bodies are carried contrariwiſe with equal Quantities of Motion, the whole Motion is deſtroy'd, and the Bodies are at reſt. Here we have the Mathematical Manner of explaining this *Phænomenon*, but Mr. *Boyle* gives a Phyſical Reaſon for it, to wit, that as no more Air preſſes upon the great Baſe than on the little one, the Preſſure is equal, and therefore the Aſcent is equal to the Deſcent; and he proves that no more preſſes upon the greater, than the leſſer: becauſe all the reſt is preſs'd againſt the Bottom of the Cylinder, ſave that ſmall Column ſtanding directly upon and equal to the Orifice, where the Communication is.

In like manner, when it is ſaid, that the Velocity of the Blood is reciprocally as the Amplitude of the Section of the Veſſels; then it follows, that the greater is the Section, the leſs is the Velocity; and as the Veſſels or Arteries, the lower they deſcend, the larger is the Sum of their Section's Amplitude: wherefore the farther the Blood in the Arteries runs from the Heart, the ſlower is its Motion; putting then S, s, for the greater and leſſer Amplitudes; V, v, for the greater and leſſer Velocity, than $S : s :: V : v$ and $S v = s V$. that is ſo much as the Section increaſes, ſo much does the Velocity decreaſe: But this Mathematical Reaſoning depends upon a Phyſical Experiment, to wit, it is found that if a Fluid runs out of a leſſer Canal into a larger, the Velocity decreaſes; but if out of a larger into a leſſer it increaſes, (at leaſt when the whole Tube is fill'd, whatever Retardation ſome will aſſert in the whole Paſſage till it is full); if the Amount of the leſſer tranſverſe Sections be not larger than the Amount of the tranſverſe Sections of the greater. However it would be great Weakneſs to imagine, that Fluids, which cohere ſtrongly, would not ſuffer a greater Retardation, than ſuch as cohere but little; this is contrary to all Fact; ſince by *Application* of the *Quantity* to the *Reſiſtance*, we ſhall find the *Velocity* to decreaſe alſo in a *Ratio* to the Coheſion, as well as to the Section's Amplitude; ſo that the Velocity is in a Compound but inverſe *Ratio* of the Section's Amplitude and the Coheſion. Whence, as the Coheſion is ſuppos'd equable every where, it is common; then it will be, putting c for the Coheſion, $Sc : ſc :: V : v$. then $Scv = ſcV$. that is, ſuppoſing the Coheſion every where alike, the greater is the Velocity, the leſs is the Amplitude, and *vice verſâ*; but if we ſuppoſe the Coheſion to differ, the Velocity will be greater, where the Coheſion is leſs. Now is there no phyſical Cauſe to be aſſign'd for this Coheſion? Do we not ſee by Experiments that our Fluids can be chang'd into very coheſive Subſtances in an Inſtant by certain Mixtures, and return'd in as ſhort a Space of Time to their former Fluidity? Are theſe ſenſible and viſible Effects always accountable for by Mathematical Demonſtrations? It is the Extent of Folly to affirm it: I do not indeed rate any *Hypotheſis* high, whereby we undertake to ſolve ſuch *Phænomena*, ſince none of them are complete. We know however, that all Bodies can be ſeparated into Corpuſcles, Particles, or Principles, call them by what Name you pleaſe, nearly homogeneal, that is, into Particles, which are for the moſt Part of the ſame Nature in every Senſe; and that when they are not, we may then term ſuch Difference an *Idioſyncraſy*, which cannot be learn'd but by Experience; nor is it accountable for by the common and uſual Principles: thus, *Sulphur* lubricates, lenifies, and mixes not with Water, and hath all the common Properties with other Oils, but then it joins in with Mercury, and enjoys ſome few other Properties, which no other Oily Body is obſerv'd to be indued with. The like may be obſerv'd in ſome few other Bodies too tedious to be made mention of here. Let theſe *peculiar Properties* be called *occult Cauſes*, *Idioſyncraſies*, *Attractions*, *Syſtematical*, or *Coſmical Qualities*, or ſay theſe Properties depend upon ſome peculiar and indiſcoverable Texture, I ſhall never diſpute the Aſſertion, ſince theſe *differential Properties* are however very well known; and without Scruple we may yet acknowledge, that Bodies have four Principles in the Senſe I underſtand the Word; and that Effects produc'd by thoſe Principles are accountable for, by one and the ſame Reaſon, in all thoſe Individuals made up of that Principle, excepting ſome few, which, tho' evidently conſiſting of the ſame ſort of Particles, yet have ſome peculiar Property, the other Individuals of that Kind are not indued with. And ſhould we brangle on *in Infinitum*, we ſhall bring this Point to bear no better; wherefore it is reaſonable to ſubmit to this Explanation, or ſome other, not a Jot more eligible; There are *Paradoxes* then in either of the Philoſophies, which we muſt ſolve into the immediate Will of our all-wiſe Creator; we ought not however to reject either, becauſe neither the one nor the other, nor both join'd, can account for every *Phænomenon* in Nature; much leſs ought we ſo to embrace the latter, as to ſpurn at the former, ſince both are helpful, but neither ſo complete as to Account for every Effect. For my Part, I admire the *Inventors*, applaud the *Improvers*, and embrace *Both* in the Art of Phyſick; and ſhall ever Repute them, who reject either, as Perſons that underſtand neither.

In the following Inquiries, therefore, I ſhall uſe this Mixture of Reaſoning, and ſhall ever Eſteem thoſe as Friends to the Publick, who, perceiving me in an Error, do with a proper Addreſs ſet me Right. The Thoughts are ſuch, as aroſe from a ſerious Reflection on the Reſpective Points that occurr'd: Men in Practice do well to Aim at a *Rationale*, on whatever odd Appearances they meet with among their Patients; how few Matters ſoever they propoſe, it is one Step more made to the Journey's End; and what may at firſt not ſeem very conſiderable, may at laſt by little Additions amount to a Sum of Value.

What I offer firſt to be conſider'd is the *Inoculation of the Small-Pox*; In which Affair, we will give you the Method uſed in *Turky*; ſome Objections to this Method will be inſerted, and probable Conjectures will be propoſed, to explain, how this odd Diſcovery, if it proves of general Uſe, may be reaſonably accounted for.

Pylarini and *Timoni* are two principal Perſons, who have firſt given us the Deſcription of this Method: the latter poſitively affirms, that *Inſition* makes the Small-Pox run their Courſe ſafely, whatever the Temperament be; but *Pylarini* obſerves, that the Symptoms after Inoculation vary according to the Diverſity of Temperaments, the Nature of the Juices in the Maſs of Blood and the Idioſyncraſy; that in Proportion to theſe Cauſes, the Symptoms are intenſe or remiſs; he moreover obſerves, that a bad *Regimen* is often fatal, and at length tells us, that for the *moſt part* (*ferè ſemper*) they are indeed of the diſtinct Kind; but acknowleges, that *one out of Four*, he had made Trial upon, *had ſo dangerous a Sort, that he was ſeiz'd with a Malignant Fever, attended with Numbers of Puſtules and bad Symptoms, and that he eſcap'd with Difficulty after the fourteenth Day.*

All the World knows the meaning of a Malignant Fever, of Numbers of bad Symptoms, and of Puſtules, as alſo of eſcaping with Difficulty after the fourteenth Day (*Ætate vero major, octavum ſuper decimum agens annum, graviter decubuit: Nam continenti febre & malignante correptus, ſuperveniente difficilium Symptomatum Syndrome, pluſculiſque quanquam non copioſis exanthematibus obrutus, vix poſt decimum quartum diem morbum eluſit*), I know only one Evaſion the *Inoculators* make Uſe of here; they ſay the Puſtules were not many, and that *Pylarini* only means the Perſon, they were grafted on, had more than are uſually obſerv'd on the like Occaſion, and in ſhort, that he had receiv'd the Infection, before they were engrafted. Theſe Triflings, beſides ſome other Suſpicions, make us willing to ſuſpend our Judgment on this ſerious Affair, till farther Trials. It muſt be acknowledg'd, that this young Man ow'd his Eſcape to *Pylarini's* Skill only, and that *Inoculation* here produc'd Effects equal to common Infection; This Accident along with his Confeſſing, that the Symptoms will vary according to an *Occult Diſpoſition*, bid fair to deſtroy at once all the Hopes we conceive from Inoculation; for as no Light can guide us into the ſecret Diſpoſition each Individual is indued with, as to the Numbers of the *Small-Pox* about to break forth; in this Suppoſition, Inoculation will ſtand upon as precarious a Bottom as Infection. Moreover, if this *particular Diſpoſition in each Individual* muſt govern the Symptoms, *Inſition* and *Infection* muſt be equal Cauſes, and it would not be more adviſeable to truſt to tranſplanting, than to ſtand the common Hazard of Contagion; for let us receive the Poiſon by what Channel you pleaſe, this occult Diſpoſition wou'd determine the Nature of the Small-Pox in ſuch manner, that we ſhould have no more for being Cachectical, nor fewer, tho' we were under a good Habit; ſince the occult Condition of the *Receiver* wou'd abſolutely limit the Degree of the Diſeaſe. Thus much we may affirm, that this is what uſually befalls us in the ordinary

Courſe of Infection; for no one has been able hitherto to aſcertain the Degree of Communication, ſince it is every Days Experience, that a Perſon converſing under the ſame Roof ſhall be ſeiz'd with the *Flux-Pox*, given from one who labour'd only under the *Diſtinct-Sort*, and *vice verſâ*; ſince in the Caſe of the Plague, as *Diemerbroeck* obſerves, good and bad Habits were equally ſubject to Seizure, and that Perſons of a bad Habit were often free, when thoſe of a good ſuffer'd; that the Seizure and Severity were promiſcuous, and that it was an *occult Diſpoſition*, not the Purity or Impurity in the Juices, which ſtamp'd the Seizure and Danger: As then it is not in our Power to aſſign, what Lengths Infection may run in any Perſon, but from the Conſequences, becauſe we have no Knowledge of this *occult Diſpoſition*; ſo if Symptoms are guided by this *peculiar Diſpoſition*, Inſition muſt vary its Chances with this *occult Cauſe*: And tranſplant from what Subject you pleaſe, it will not be in your Power to give a bad Small-Pox from *Pus* drawn out of the *Flux-Sort*, nor a good *Species* from the *Pus* of the leaſt virulent; if this *occult Diſpoſition* varies the Manner of Invaſion: And as this Diſpoſition ſometimes enervates Contagion in ſuch manner, as to protect Perſons living among the infected from receiving the *Labes*, in the ſame Faſhion it happens, and from the ſame Cauſe alſo, that Inſition it ſelf fails of Succeſs; whence *Inoculation*, ſuppoſing a bad Diſpoſition, and this we are in the Dark about, may thwart the firſt Principle of Nature, and from *Self-Preſervation* will make us guilty of *Suicide.*

If the *Temperaments* and the *Nature of our Juices*, have any Influence on the Degree of the Small-Pox; it muſt follow, that the Change of *thoſe* will diverſify *this*, and that an Exchange of a good Habit for a bad one, will alter the Scene of Invaſion, in proportion to this laudable Habit introduc'd: So that there would be no Hazard, after ſuch a Proviſion, in expoſing our ſelves, either to an infectious Air, or to the Operation of Tranſplanting; becauſe bringing Bodies to a juſt Temperament, is a Work Phyſicians are well skill'd in; and this Affair being accompliſh'd, no Reaſon can be aſſign'd, why we may not run the Riſque of an infectious Air, as well of *Inoculation*; for, in this Suppoſition, bad Symptoms could never accompany a juſt Temperament, which is in our own Power to introduce; and ſhould the Reverſe happen, we might lay the Fault at our own Doors.

If *Pylarini* means, that the Symptoms vary according to the Temperament, and this *occult Diſpoſition* jointly; it will appear ſometimes to include an Inconſiſtency; for the Temperament may be very juſt, whilſt this Diſpoſition will be found to be virulent, and *vice verſâ*; So that Perſons carefully prepar'd will yet have the *Small-Pox* in a very violent Manner; and others, whoſe Conſtitutions are ſhatter'd, and whoſe Juices are wonderfully deprav'd, tho' neglected, will upon Infection have them of the gentleſt and meekeſt Sort. We are by no Means Maſters of any Methods, how to change this Diſpoſition, or how to diſcover its Nature; ſo that theſe Temperaments have no Influence on this Idioſyncraſy; and *Inſition* muſt fare according to *this* only, and not *thoſe*: And as we are intirely in the Dark in this Affair, the Perſons, into whom the Small-Pox are tranſplanted, can have no other Chance, than what this Peculiarity determines them to enjoy; wherefore ſhou'd a deprav'd State of Humors concur with a bad Diſpoſition, the Small-Pox would run dangerous Lengths, with Inſition as well as with Infection; and to have them favourably, it would be requir'd, that the Temperament and Diſpoſition ſhould both be good, which does not hold true. Whence it cannot be, that the Species of the *Small-Pox* depends upon them jointly, ſince let the Temperament be ever ſo bad, but the Diſpoſition good, they will be favourable; and *vice verſâ*, let the Temperament be the beſt, but the Diſpoſition bad, the Perſon ſeiz'd will have them dangerouſly.

Since therefore the Small-Pox will not break forth, but according to this Diſpoſition, if regard is had to ſuch Conſiderations as *Pylarini* recounts, let us ſee whether *Timoni*'s Account will better anſwer the End; He expreſly ſays, let the Habit be what it will, nay even a diſeas'd one, or the Diſpoſition be never ſo occult, for he excepts no Perſon from the freedom of Engraftment, the Operation ſtill ſucceeds;

ceeds; This Gentleman living in *Conſtantinople*, and having ſpoken upon Experience of eight Years ſtanding, ought to be more followed: This Account agrees with Mr. *Maitland's*, who ſeems to have no Regard to Temperament or Diſpoſition at all, and who neither prepares nor asks any Queſtions concerning Conſtitution, only chuſes a proper Time of the Year, leſt a cold Seaſon ſhould repell the Eruption. From what is ſaid, I conclude in the following manner.

Pylarini, tho' he circumſcribes the Operation, yet falls in with it as ſucceſsful for the moſt Part: He obſerves, that it often proves fatal, in Caſe of a bad Regimen, and that a ſtrict one with Preparatives are neceſſary: Whereas the others entirely ſlight this Caution. May not ſome Perſons then have the ſame ill Chance, as *Pylarini's* Patient had, upon ſuch a Neglect? When theſe Gentlemen accord better upon the Matter, it will be eaſier to judge, what will be the Conſequence, which Experience alone muſt inform us better in. For if *Pylarini* has found upon Experience or Enquiry, that an ill *Regimen*, or want of Preparations, have proved fatal, it muſt be concluded, that *Timoni's* Aſſertion was groundleſs, when he affirm'd, that Perſons under the worſt of Habits did always recover upon the Engraftment; or if all Perſons did recover indifferently, and without any Preparations, why does *Pylarini* intimate to us, that if Perſons are unprepar'd, or they obſerve an ill *Regimen*, they run a Riſque by undergoing this Operation? I leave theſe Gentlemen to reconcile their Differences, which ſeem to be ſo wide; one of the two muſt vary from the Fact, ſince Contradictions cannot be true at one and the ſame Time; and I muſt conclude it ſomewhat precarious for Perſons of Eſteem to hazard their Lives upon ſuch a Practice, till theſe Hiſtorians do agree better about the previous Methods concerning this Operation, till we are better aſſur'd, that ſuch as have been under their Hands, will never be ſubject again to the Diſeaſe; concerning theſe, we are under an Uncertainty, which it behoves the Operators fully to ſatisfy the World in, before they can expect them to fall into their Meaſures; and moreover, they ought to have ſatisfied the Gentlemen, who viſited the *Inoculated*, that theſe Pimples which did appear, did not retain to a Diſeaſe common enough in Priſons.

Notwithſtanding all this Caution of mine, and the Diſagreement of the Operators, I am yet very ready to give in to a Practice, which is ſaid to be ſucceſsful, but it is reaſonable that the Nation ſhould firſt be better convinced, otherwiſe they muſt expect few Proſelytes, and repeated Experiments only can be convincing. Then, and no ſooner, ſhall we be aſcertained of the Matter of Fact; then ſhall we be able to ſpeak by Experience, whether *Timoni* or *Pylarini* are in the Right; then ſhall we know, whether theſe Small-Pox, given by Innoculation, be preventive of thoſe taken by Infection; then ſhall we be aſſur'd, whether there be any Difference in taking the Small-Pox from one by converſing in the ſame

Room, or by Inſition; and then ſhall we find out the Reaſon, why *Inſition* (if it be ſucceſsful always) ſhould be introduced, and embraced, before all other Means yet known.

This *occult Diſpoſition* has obtained the Name of *Seminium*; but it is not very eaſy to ſay what it is: It cannot be the Blood alone, for then all Perſons would be indifferently ſeized with an Infectious Air at any Seaſon, nor could any one eſcape Fevers, Small-Pox, or ſuch infectious Diſorders, whenever they raged; ſince they would ever contain a proper Subject for Reception at all Times; and in this Suppoſition, it would be no new Thing to hear of Perſons labouring a Hundred Times under the ſame Epidemical Diſeaſe, which is evidently contrary to daily Experience: Wherefore the Blood, as Blood, cannot be this latent Diſpoſition. Dr. *Pitcairne* looks upon a *Lentor* as the immediate Cauſe of this Infection; but this *Lentor* cannot be this Diſpoſition, ſince it is the very Diſeaſe in *Embryo*; and no ſooner has the Blood received this Ferment, but the Diſeaſe begins to exert its Force, and run its Courſe; for acute Diſeaſes have nimble Cauſes, and like moſt animal Poyſons, exert their *Virus* in few Hours after Reception; or however, ſuppoſe this Poyſon very ſlow in its Effect, (which is unreaſonable to be granted), ſtill that *ſecret Cauſe*, which dispos'd one Perſon rather than another, to give Entrance to this Poyſon, Ferment, or what other Name you pleaſe to give it, is the *Diſpoſition* here ſpoken of. Since then neither the Blood, nor this *Lentor* are this *oc-*

cult Diſpoſition, let us examine what it may be; we have conſider'd the Blood as common Matter, we have look'd upon *Lentor* as Form, or an Eſſential Modification conſtituting the particular *Species* of a Diſeaſe; we muſt then conſider this *occult Diſpoſition*, as the Reſult of ſome peculiar *Shape*, *Magnitude*, *Poſture*, *Order*, or *Texture* of the Blood, and muſt therefore look upon it as an Aſſemblage, either of the *primary* or *ſecundary Affections* of this *Matter*, or of both; and the Cauſe of one Perſon's receiving an Infection, and of another's eſcaping, muſt be, that the Blood is ſeldom or never fitted with theſe Affections a ſecond Time, as it was the firſt; whence, whoever are once ſeized with any infectious Diſeaſe, ſeem to have an Aſſurance, they ſhall eſcape that Malady for ever after; and indeed Experience very much favours this Confidence, ſince very few of ſuch as have any infectious Diſtemper in a violent Manner once, are never ſeiz'd a ſecond Time with it. However, it is not in the Power of Mortals to know, what in particular theſe *Affections* are, or how much a Perſon is diſpoſed to receive Infection, or what Quantity his Blood is capable of digeſting or expelling; theſe are Secrets we ſhall ever be enquiring after, and yet ſhall never be able to diſcover; wherefore I ſhall receive this Word, *occult Diſpoſition*, as ſignificant enough, and do look upon a *Seminium* and this occult Cauſe, as *ſynonymous*.

We now come to conſider, what Good may be done by Preparatives; we know that *Plenitudes*, *Viſcoſities*, or *Acrimonies*, do always produce dangerous Symptoms in our Bodies, and as in the *Small-Pox* there are plain Tokens of theſe Cauſes reigning within us, ſo *Evacuation*, *Dilution*, and *Attenuation*, anſwering the Indications fully, are juſtly reputed proper Remedies for this Diſeaſe; where the Blood-Veſſels are charg'd with Contents, they are in Danger of burſting upon any Rarefaction of their Fluids, and no Reaſon can be aſſign'd, why this additional Quantity, or at leaſt, why this Quantity filling a greater Space, ſhould not be drawn off. *Viſcoſities* are the Cauſe of Inflammatory Symptoms, and as very many Inflammations are obſerved in the *Small-Pox*, ſo thoſe Medicines, which gently attenuate and diſſolve the *Coagulum*, will make that Fluid, which was before nearly a Solid, and render the Inflammations leſs intenſe. *Acrimonies* render the Blood eager, keen, and corroſive: we need not much diſpute, that the Humours in the *Small-Pox* are ſuch, ſince we ſee ſo many ſignal Proofs of Acrimonies; and therefore *Diluters*, and *Correctors* of *Acrimonies*, are prudently adminiſtred by Phyſicians in this Diſtemper; ſince the Small-Pox then are obſerved to produce Inflammatory Symptoms, Corroſions, and Effuſions of Blood, it can be no contemptible Advantage, to take off this ſuperabounding Quantity, to render the Blood fluxile, and to ſheath its corroſive Salts.

I think we may conclude, that Preparatives are uſeful to enervate and correct the Humours, but that this *ſecret Texture* is by no Means altered by ſuch Methods; that this *Diſpoſition* may as well be heightened as abated by all Applications, for any Thing we know to the contrary, ſince it is own'd by all Sects of Phyſicians, that we are utterly in the Dark as to its determinate Manner of exiſting; but however, as there are convincing Proofs, that the Cauſes named do exiſt, they may be cured, and by Conſequence prevented; wherefore do Phyſicians wiſely premiſe Preparatives, in order to guard the common Conſequences of the *Small-Pox*; and ſince we are not acquainted as yet, with any proper Antidote againſt the *Virus* of the Diſeaſe, at leaſt it muſt be granted, we make uſe of proper *Succedanea*, till ſome lucky Chance lets us into the Secret.

Having ſpoken enough concerning this *Diſpoſition*, it remains for us to enquire, why, ſuppoſing ſuch an occult Diſpoſition, the *Small-Pox*, ſhould yet always be of the better Sort from *Inſition*, altho' not from *Infection*, granting what *Timoni* and *Pylarini*, and the Inoculators affirm to be true.

To be able to diſcuſs this Point, we muſt take a View of the Nature of Poyſons, and their Differences. It is very obſervable, that ſome Poyſons act by producing an immediate Change in the Blood, Spirits, or Parts, and others by raiſing a Fermentation in the Juices; that the former Poyſons have determinate Conſequences, but that the latter oblige us to wait the Conſequences; and altho' it be introduced by a Salt, or other Principle of a determinate Nature, yet are we often oblig'd to throw into the

Blood, Medicines analogous to the very producing Cauſe, in order to put a Check to the Effects; for be it that the Juice of the Viper is acid, it may however be *ſometimes* requiſite to adminiſter Acids themſelves, in order to put a Check to the violent Commotion rais'd: I do not affirm, that Acids are convenient *Alexipharmac's* in the preſent Caſe always; for it is evident enough, that I ſpeak in a limited Senſe; becauſe, as the Bite *generally* makes the Part and the Blood black, coagulates the Juices, brings cold Sweats, and *in fine*, cauſes Coagulation and Stagnation, it is moſtly agreed on by all as reaſonable, to give volatile or fixt Antidotes, to prevent the Conſequences.

Since then Poiſons affect the Juices, either in particular, but determinate Ways, or in a more univerſal and unlimited Manner; we may juſtly repute *Inſition* (if it be always ſucceſsful) to act in the former, and *Infection* in the latter Senſe, that is, *Inſition* acts as a common Poiſon, and *Infection* as a Fermentative one. And as Phyſicians are well skill'd in the determinate Effects of common Poiſons, inſomuch as to be able to adminiſter ſome of them internally with Safety, becauſe their Doſe is well enough known; ſo the Poiſon inoculated runs certain Lengths in the Blood without fermenting it, and yet gives the Small-Pox; whereas Contagious Particles are in full Force, they enter the Blood with all their Virulency, and ferment it into this Diſeaſe. Moreover, it is an Obſervation worth Remark in our preſent Caſe, *That moſt ſecreted Humours (of one* *and the ſame Animal, or Species of Animal) being adminiſtred internally, do never again undergo Fermentation, but are carried in a Manner without any or little Change to the very Parts they are ſecreted from, they enter thoſe ſecretory Ducts again a ſecond Time with Eaſe, and promote that Secretion.* So Urine adminiſtred internally, is a good Diuretick, and it does not ferment any where; wherefore, as whatever ferments in the Blood produces a great Change in the Liquor fermented, ſo if that which has been once fermented, ferments again, it ſtill produces a greater Change in the Fluid ſo agitated; wherefore, as the *Effluvia* (from Perſons infected) receiv'd do agitate our Blood and Humours, as Experience daily informs us, the Reception of them is dangerous, becauſe they are a fermenting Poiſon; but as *Pus* inſerted does not ferment, it muſt only be a common Poiſon; acting in a limited Manner, and producing Effects leſs dangerous.

Before I proceed to the remaining Points, it is neceſſary to premiſe ſome few Propoſitions, which we are to preſuppoſe, and on which the following Proofs have their Dependance.

Firſt, Motion conſiſts in a ſucceſſive Change of Place,. and this Change is an Effect of a firſt Mover. *Ph. Burg. Pr.* 2. *Diſſ.* 2. *C.* 1. *p.* 1.

Secondly, This Change is proportionable to the moving Cauſes, which in the preſent State of Affairs is always made by Contact. *Barth. Spec. Phil, c.* 5. *p.* 34.

Thirdly, This Proportion is as the Magnitude, Denſity, and Velocity of the Body moved. *Newton.*

ton. Prin. A. Thomas, p. 392, 393. *Tract.* 7. *de Aq. Fluxu.*

Fourthly, Bodies moved are carried iu the Line of Direction impreſs'd, and, unleſs that Line receive ſome new Impreſſion, they continue to move in their firſt Line. *Newt. Princ.*

Fifthly, That Change, or new Impreſſion, added to the former, makes a compound Motion determinable. *Id.*

Sixthly, Heat is a *Vis motrix*, compounded of the *Vires acceleratrices*, and the Quantity of Matter in the Body.

Seventhly, The Contact of Circles is only punctual. *Eucl. L.* 3. *El. Prop.* 13.

Eighthly, One Sphere may be touch'd in 12 Points, by Twelve equal Spheres. *Newton, Cheyne.*

Ninthly, Attraction is found to equal, to be leſs than, or to be ſuperior to, Gravity. *'sGraveſande.*

Tenthly, That is called a Radiating Point, from whence Qualities are communicated to various Diſtances: So the Sun or Fire are ſuch Points, becauſe Heat is darted from them to very great Diſtances.

Eleventhly, That Property or Affection, which is ſeparable, and which may be remiſs or intenſe, is not an univerſal or general Attribute or Quality, but a particular and accidental one.

Twelfthly, Attraction, of Bodies floating in a Fluid, is not deſtroy'd, whether thoſe Fluids be uniformly or unequally mov'd, or they be at Reſt: but they are equally attracted in an uniform Motion, or when the Fluid is at Reſt.

Having ſuppos'd theſe Propoſitions as granted, I proceed to the firſt Point, to wit, *What is the Reaſon of the Heat in our Blood?*

There are two Things very remarkable in human Bodies, on which all our Functions have their Dependance, that is, the *Circulation* of the Blood, and its *Heat*; we are ſenſible of the *latter*, and are convinced of the *former*: We ſhould be reputed too vain to believe it in our Power to diſpute Mankind out of their Senſes, and thereby model the Art of Phyſick anew, as Dr. *Harvey* did with his happy Diſcovery of the Circulation; it is therefore incumbent on us to enquire into the Nature of Heat, that we may know why our Blood is hot, and by what Means it becomes ſo.

The Touch and the Thermometer are Teſtimonies of the Heat of our Blood and Parts, and it appears too *paradoxical* to ſuppoſe, that ſober Men ſhould go about to prove there is no Heat in the Blood; however groundleſs this Aſſertion may be, there are not wanting *Some*, who, by ſtrenuouſly oppoſing the various Cauſes whereby Heat is rais'd, muſt neceſſarily alſo deny the Heat in our Blood. For if we have Recourſe to inſufficient Cauſes, and reject all ſuch as Experiments convince us are productive of this Effect, we, in Truth, do no leſs than deny the Evidence of our Senſes for the Sake of introducing ſome equivocal Proof only. To deny therefore that Heat is produced from a Luctation, and to aſſert that it *only* proceeds from the Circulatory Motion in the

Blood, is to deny flatly *totidem verbis* the Heat of the Blood; as will appear clearly from what follows.

All Philoſophers, whether ancient or modern, agree about the Cauſes which produce Heat; and however they differ in expreſſing themſelves, yet they concur in aſſerting, that *Heat is produced by a diſturb'd and rapid Motion of the minute Particles of a Body*; That, *Heat is a various and rotatory Agitation of the inſenſible Particles contain'd in a Body, one againſt the other*; That, *Heat is a local Motion of the ſmall and inſenſible Parts of a Body mechanically modified by a vehement Agitation, and a various Determination*; That, *Heat is a Motion of the Particles which fall not under our Senſes*. That, *Heat depends upon a violent Motion rais'd among the Particles of the Fluids, from whence it appears that the Particles of two heterogeneous Fluids, whilſt they are mixing, cloſe in with each other with a great Force, and conſequently ruſh towards each other with an accelerated* Motion *and Attraction.*

I have judg'd it proper to ſet down the various Manner which Philoſophers have hitherto made uſe of to expreſs their Conceptions about Heat; becauſe I would anticipate all Brangles, which proceed from the want of having fixed our *Idea* concerning the Matter in Hand. From which it follows,

That this *Motion*, this *Agitation*, this *Determination*, or this *Attraction* is not made between the homogeneous Particles of Matter amongſt each other, ſince then there would be an immediate Union and no Heat would enſue, but the Particles would then be truly at Reſt; however the Fluid chang'd its relative Place; but muſt depend upon a mutual Attraction and Repulſion of theſe inſenſible Particles amongſt each other, untill an entire *Saturation* happens, when Heat ceaſes, becauſe its Cauſe vaniſhes: If therefore any Solid or Fluid is continually hot, this Attraction and Repulſion muſt always continue; or there muſt be ſome Principles, contain'd in that Body, which are under a continual Motion: Now *homogeneous Particles* would not continue in motion, but unite; wherefore *Heterogeneous* ones are the fitteſt to produce Heat. If Attraction were ſuperior to Repulſion, the Blood would cohere and ceaſe to be hot; therefore theſe Forces are nearly Equal, but continual.

Whether we ſhall ever be in a Capacity, to diſcover *a priori*, which Particles are heterogeneous, which not; or whether we ſhall ever be Maſters of the Cauſes of this Heterogeneity, is not the Queſtion's I undertake to decide here, it is enough there are evidently Such in Nature, that for the moſt part Oils and Acids, that volatile or fixt Salts and Acids are found to be theſe Heterogeneous Particles, which huff, elevate, efferveſce, and grow hot with each other, and which are found upon Saturation, to ceaſe from theſe Motions, that theſe and theſe only are the P*articles, apt to produce Heat* in Bodies, and that the earthy and watry Particles have no Share in this Motion.

Since therefore this Sort of Attraction, which produces Heat, is only found to ſubſiſt, where there are heterogeneous Particles in a Body, it follows, that this Motion depends ſolely upon the Inteſtine Struggle, rais'd between theſe heterogeneous Particles in Bodies, and that the Blood derives its Heat from no other Cauſe; if a direct or circulatory Motion in the Blood alone were the Occaſion of this Heat, it would follow, that a like Motion in any Fluid would render that Fluid alſo hot; which does not happen in Torrents nor Raging Seas, from whence Heat neceſſarily includes ſome additional Motion to the progreſſive; but there are no other beſides theſe two in Fluids, therefore it muſt be the Inteſtine Motion, that raiſes Heat; that is, it is not a direct, but an irregular Motion, rais'd among Particles containing Fire, which exerts it ſelf by Attrition.

The *Ingenious Dr. Pitcairne* objects againſt an Inteſtine Motion, that it holds univerſally true, *that there is no Inteſtine Motion of the Particles of any Fluids, contained in a moving Veſſel*: which is contrary to a known Fact of every Day's Experience, to wit, Place Oil of Turpentine along with Oil of Vitriol, in a Glaſs Viol, ſhake them, and wait the Conſequence; this Breach of the Glaſs does not depend upon the Motion of the whole, but upon a Rarefaction, enſuing upon the Mixture of heterogeneous Bodies, which, wanting Room for ſo ſudden an Expanſion, preſs violently on all Sides with Vehemence, and the Veſſel muſt run over, or burſt, which laſt is the neceſſary Conſequence, when the Viol is clos'd with the Finger.

He alſo objects, that *Homogeneal Fluids in a Spherical Veſſel equally preſs'd upon, can neither approach to, nor recede from, the Center nor Circumference, nor change the Poſition, and that therefore they will continue at Reſt; becauſe at an Equi-diſtance from the Center or Circumference, the Particles, gravitating equally, gravitate with the whole, and there will be no Motion.*

But Preſſure, whether equal or unequal, does not leſſen the Power of Attraction; which, as Particles approach nearer to a Contact, becomes the ſtronger, and often ſuperior to the Power of Gravity, as many Experiments made on this Point do atteſt; for where *Attraction* obtains, a Fluid will not run down to a Level, which it ought to do by its Gravity; and *vice verſâ*, where *Repulſion* obtains, it does not mount up to a Level, which by its Gravity it ſhould, and therefore *Attraction* and *Repulſion* are often ſuperior to the Laws of Gravity; whereas therefore the Laws of Attraction obtain in our circulating Fluid, or in our Veſſels, the Laws of Gravity muſt be ſuſpended ſo long as they are leſs intenſe than thoſe of Attraction, and in ſuch a Caſe, a Motion of the Particles of a Fluid amongſt themſelves, would follow upon ſuch an attractive Power in the reſpective Particles, which Motion is neither circulatory nor progreſſive, therefore Inteſtine. Moreover, if by *homogeneal Fluids*, are underſtood Fluids, which have equal Denſities and ſimilar Particles, the whole is granted, but then it proves Nothing againſt inteſtine Motion.

Having prov'd that *an inteſtine motion will not ceaſe in a moving Veſſel*, and that *Attraction is ſtronger at the Point of Contact, or at a ſmall Diſtance from it, than the Power of Gravity*, I think a Fluid, which in a ſtrict Senſe, may be term'd *heterogeneous*, both by reaſon of its Particles, and the Denſities of them, muſt neceſſarily be allowed to enjoy an inteſtine Motion; ſince Preſſure and a Ceſſation of inteſtine Motion in a moving Veſſel, are groundleſs Aſſertions.

It is evident in Chyle and Milk, that there are ſuch Particles as will attract or effervеſce with each other; and alſo, that when they have fully imbibed one another, they will effervеſce no more; theſe Particles wou'd have no ſuch Effect, if there were not a Diſſimilitude, or an Heterogeneity between the Principles of the Chyle; for want of ſuch, the Blood would ſoon ceaſe to effervеſce, as it happens in Famine, where the Blood's Heat gradually diminiſhes, it unites into a Coagulum, and a full Stop is put to the Circulation. The Blood running off every Moment by various Emunctories, cannot be reputed the ſame and individual Blood to Morrow, which it is to Day, wherefore, it is a Fluid to which freſh *Supplies* are conſtantly added, and from which many Particles are ſubtracted every Inſtant of Time; ſo that it cannot be the ſame and numerical Fluid very long. The *Supplies* as well from Diet, as from a *Return* of the ſecreted Particles into the Blood, are Compoſitions of fermentative, efferveſcing, luctating, heterogeneous, attractive, igneous Particles, of which the Blood, by reaſon of the many Secretions drain'd from it, had been nearly depriv'd: Wherefore, as Heat muſt decay without Fuel, ſo the Continuance, or the Increaſe of it depends upon an Application of new Fire, and an Agitation of the igneous Particles in the Body.

The learned Dr. *Pitcairne* does not diſown an Acidity in the Stomach, but then looks upon it to proceed from our Food ſtagnating there, and imputes it to the Fault of the Stomach, and adds, that the Stomach being out of the Road of Circulation, is without the Animal.

Let us admit of this ſtrain'd Suppoſition, does not the Stomach in a few Hours communicate with the Blood? how putrid, how ſour ſoever the Contents of the Stomach are, they are hurried into the Maſs with little Change of their Qualities; the Extrication of Particles by the Comminution of the Solids, and Luctation here, perpetuate both the Circulation and the Heat; thoſe Salts we taſte in the *Serum* and *Urine*, which are found upon Trials to be *marine*, convince the thinking Part of Mankind, that we want no *Acid* in our Blood, however hard it is to be obtain'd, for it is ſcarce ſeparable ſometimes; and the *oleoſe* are demonſtrably prov'd by the *Bile*, Fat, and Butyrous Parts, which without the Torture of Fire appear ſpontaneouſly.

Wherefore Dr. *Henſhaw*'s Reaſon for the Heat in our Blood, ſeems very probable, to wit, a Diſſimilitude between the Particles of the Blood and *Chyle.* The Chyle (being ſtock'd with Acid Particles, which are confeſſed to be endued with a great attractive Force, and which move Fluids ſo as to excite Heat, and occaſion Fermentation) is a *Pabulum* for this Efferveſcence, which is continual, becauſe the Supplies are ſo. As then the more heterogeneous are the Particles of the Chyle and Blood amongſt themſelves, the greater is our Heat; and as nothing can give, what it hath not, ſo there could be no Heat in our Parts, if the Blood did not contain Fire; the *vis acceleratrix* depending on the various Modifications of theſe Particles: The greater Denomination it hath, the greater will be our Heat.

If then we put *q* for the *Moles* of Blood, *a* for the *accelerating Force,* and *h* for the *Moment* of Heat, we may compute the *Quantity of Heat* in any Body.

$$\text{For } \frac{h}{q} = a;\ \frac{h}{a} = q;\ aq = h.$$

Coroll. The Heat of the Blood may be infinitely decreaſed, whilſt its Cauſe may be augmented.

Becauſe Gravitation, at a ſmall Diſtance, is directly as the Quantity of Matter: But the Coheſion is in a direct *Ratio* of this Gravitation: Wherefore the Coheſion is directly as the Quantity of Matter; but the Coheſion is inverſely as the Velocity: wherefore the Velocity is inverſely as the Quantity of Matter: Whatever then augments the Coheſion, impedes the Velocity; but what impedes the Velocity (*cæteris paribus*) diminiſhes our Heat: wherefore, whatever augments the Coheſion, diminiſhes our Heat. The Coheſion is occaſioned from Bodies endued with little Agitation: but Bodies in a depreſſed State whether vegetable, mineral, metallick, or animal, are endued with Particles of ſmall Agitation: wherefore, ſuch Particles circulating in our Veſſels, diminiſh our Heat, and increaſe the Coheſion or Viſcidity of our Fluids. Bodies in a depreſſed State are ſtocked with unactive Particles, and clog the Motion: therefore they deſtroy the Heat in firm Bodies. *Q. E. D.*

fluid

Whence the actual Heat may be infinitely diminiſhed, whilſt the potential Heat, or Particles apt to produce Heat, may be abundantly contained within our Veins, but without the Conditions neceſſary to produce it. Phyſicians therefore ſhould weigh ſeriouſly the Cauſes, whether, to wit, the Blood may not be too *Aqueous*, too *Tartareous*, too *Homogeneous*, or whether the *Air* may not be crowded with *Particles impeding Fermentation* (*abundat enim Aer Vaporibus acidis fermenteſcendo aptis; ubi videre eſt ex eo quod —— Cordis Pulſus in animalibus Reſpiratione conſervetur.* Sir *Iſ. Newton, Optic. Ed. Lat.* 1. *p.* 326.) Or if any other ſuch Cauſes prevail as make our Fluids cohere, the Heat will be diminiſhed in a direct *Ratio* of the Exceſs or Difference of theſe above the augmenting Cauſes. And it is the Phyſicians Duty to collate the Symptoms, that he may know how to adapt a proportionate Remedy; ſince what is noxious cannot be expelled, until the Blood's Heat be augmented to a determinate Degree, by Remedies, which ſpecifically reſiſt Coheſion, which by Experience ſeem too ſurely to be the Caſe in all the *Low Fevers*, of which more in its Place.

If then we have the determin'd Degree of Heat by a *Thermometer*, and the Quantity of Fluids in any Section by the Weight of them. (*v. Keill, p.* 39. *OEconom. Animal.*) the *Vis acceleratrix* is given.

If the *Moles* and *Vis acceleratrix* be given, the *Moment* is alſo given.

If the *Vis acceleratrix* be given, the Heat is as the *Moles* of Blood.

If the Quantity of Blood be given, the Heat is as the *Vis acceleratrix*.

If neither the *Quantity of Blood* be given, nor the *Vis acceleratrix*, the Heat is in a compound *Ratio* of the *Moles* and this *Vis acceleratrix*.

The next Point under our Conſideration, is to determine *the Degree of Heat under each Diſtance from the Heart.*

Dr. *Pitcairne* ſays, that the Heat of the Blood may be conſider'd as a Rectangle under the Velocity and the Proximity; That is, if the Velocity be 3 in any two Perſons, and the Proximity be twice as much in one, as in the other, or as 2 to 1; the Heat of the firſt will be as 6, and of the latter as 3, ſo that the Heat of the firſt will be more then double the Heat of the ſecond; if the Proximity of the firſt, be as 2, and the Velocity as 4, but the Proximity of the Second, as 3, and the Velocity as 1; the Heat of the firſt will be as 8, of the Second as 3, and ſo the Heat of the firſt will be double the Heat of the Second.

It appears by this Computation, that as the Blood's Velocity is greater near the Heart, and its Diſtance from it leſs, the Blood, the nearer it approaches to the Heart, would be the hotter, and the Heart would be a ſort of a Furnace; for if we ſuppoſe the Blood's Velocity to decreaſe, as its Diſtance from the Heart encreaſes, then at the Extremities, or at the Ends of the Veins, the Proximity and Velocity being equal to nothing, the Heat muſt *quàm proximè* vaniſh there; for if we ſuppoſe the Vicinity and Velocity to decreaſe in any Progreſſion in any given Ratio infinitely, we ſhall find that the Laſt will be a Cypher; let it decreaſe, for Example, in a *Geometrical Progreſſion*, then

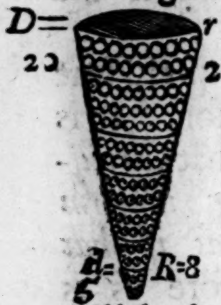
$\frac{ra}{r-1} = s$ and $l = 0$; for let $r = 2$; $a = \frac{1}{2}$;

$$l = 0; \text{ then } \frac{ra}{r-1} = s = \frac{2 \times \frac{1}{2} = \frac{2}{2} = 1}{2 - 1 = 1} = 1;$$

that is, the Sum of ſuch a *Series* of Numbers infinitely decreaſing in a Geometrical Progreſſion, whoſe Firſt is $\frac{1}{2}$, and which decreaſes thus, $\frac{1}{2}$ — $\frac{1}{4}$ — $\frac{1}{8}$ — $\frac{1}{16}$ — $\frac{1}{32}$ — $\frac{1}{64}$ — $\frac{1}{128}$ — $\frac{1}{256}$, &c. is only $= 1$; and its Laſt is ſo infinitely ſmall, that the only Way we can expreſs it, is by a Cypher$=0$; or ſuppoſe $\frac{2\times 100=200}{2-1=1}=200$; ſtill it will decreaſe thus $200-100-50-25-12\frac{1}{2}-6\frac{1}{4}-3\frac{1}{8}-1\frac{1}{2}\ \frac{1}{16}-\frac{1}{2}\ \frac{1}{4}\ 3\frac{1}{2}$, &c. till the Laſt $=0$; or if we ſuppoſe the Vicinity and Velocity to decreaſe in an *Arithmetical Progreſſion*, then $l=\frac{2s}{n}-a$; ſuppoſe the Number of Terms $(=n)=100$; and $s=$ to the Sum $=100$; $a=$ to the firſt Term $=2$; then $l=0$; for $\frac{2\times 100=200}{100}(=2$; and $2-2=0=l$; wherefore in ſuch Suppoſitions the Blood wou'd actually be cold at the Extremities, it would then Stagnate and run no longer; or put $P=200=$ to the greater Proximity and $p=1=$ to the leſſer; $V=18=$ to the greater Velocity, $v=2=$ to the leſſer; $H=3600$, $h=2=$ to the greater and leſſer Heat, then $PV:pv::H:h$; then the greater Heat will be to the leſſer, as 1800 to 1, which is a *Chimæra*.

Now as this is contrary to Experience and Fact, we may with Reaſon affirm the Heart to be *no radiating Point*; ſince were it ſo, the Blood would be found to be hotter there than it is at the Extremities, which *Borelli* upon Trial al found to be erroneous: For by uſing and applying *Thermometers* to the Heart and Extremities, the Heat of the Blood in the Extremities mounted it to an equal Degree with that in the Heart, ſo that it appears to be Fact, that the Blood is every where alike hot; wherefore it is conſonant to Experience to infer, that the Heart is not the Center of Heat; nor the radiating Point; which indeed is every where; for the radiating Point is equal, wherever the Cauſes producing it are equal: Now as theſe Cauſes productive of Heat, are equal at all Diſtances from the Heart, it follows, that this Center or this Point is as intenſe at the Extremities, as at the Heart; (for equal Cauſes produce equal Effects, and the Blood, which is at the Heart this Inſtant, is hurried to a great Diſtance from thence, the next, and yet retains the ſame Degree of Heat:) Therefore *Particles apt to produce Heat*, only radiate where they exiſt, or at moſt, ſo far as their Sphere of Activity reaches; but as this Sphere is known by Experience to reach no farther preciſely, than to the Periphery of the tranſverſe Section of the Artery, where theſe Particles exiſt at that Inſtant; ſo it is evident that the Blood is no hotter for its Vicinity to the Heart, nor cooler for its Diſtance from it, but is equally hot, where the luctating, effervеſcing, attracting, igneous Particles are equal; and as they are moſtly no where more plentiful than other; wherefore equally copious at the Extremities, as at the Heart, (the Blood being as heterogenous at the Extremities as at the Heart); it follows that the Blood is no where hotter than other, that the Heart is no Center of Heat, that it is no radiating Point; and that therefore Heat is no Rectangle under the Proximity and Velocity.

Let us therefore ſee how *Borelli*'s equal Heat at all Diſtances will conſiſt with Reaſon. It is agreeable to a Principle of Attraction, that *Corpuſcles floating in a Fluid mov'd with an uniform* Motion, *attract each other as much as if that Fluid were at reſt.* So much therefore as is wanting to an uniformity of Motion at any Section of the larger Veſſels, ſo much preciſely, is wanting to a State of Reſt, at a correſpondent Section of the Capillaries, the Velocity of the whole Maſs being a mean Arithmetick Proportional between the greateſt and the leaſt Velocity; wherefore the *vires motrices* in each Caſe will be equal: for as the Motion in the large Veſſels is not equable, in like manner, neither is the ſlow Motion at the Extremities a State of Reſt; And therefore the Blood is as hot at the Extremities, as at the Heart: Becauſe the Uniformity at *D r* is proportionable to the ſlow Motion at *d R*; and altho' there neither is an abſolute Uniformity of Motion, nor State of Reſt in our Veſſels during Life; yet there are near Approaches to the former at the Heart, and to the latter at the Extremities: hence it is, that in elaſtick Bodies, the elaſtick repelling, and attracting Force encreaſes, as the Diſtance of each Particle from another's Center diminiſhes; but in larger Veſſels, the Diſtances from the Centers encreaſe, and in leſſer they decreaſe; wherefore in larger Veſſels, the Attraction and Repulſion will be leſs; and in leſſer, greater in Proportion to the Bodies contain'd, as may appear by the Figure annexed.



Let *D* and *d* be put for the greater and leſſer Diſtance from the Centers; *R* and *r*, for the greater and leſſer Degree of Attraction, or Repulſion; and let it be $D:d::R:r$. Then it will be $Dr=dR$ So that the Rarefaction of the Blood will be in an inverſe *Ratio* of this Attraction, and Repulſion, or Elaſticity and this of the Diſtance.

Now as $Dr=dR$, the Sums of Attraction and Repulſion will be equal; let $D=20$; $d=5$; $R=8$; $r=2$; then it will be $20:5::8:2$, and $20 \times 2 = 40$; ſo will $8 \times 5 = 40$ alſo; therefore the attracting Forces are in an inverſe *Ratio* to the Diſtance of the Centers of the attracting Particles.

Wherefore 20 Spheres, each of whoſe Centers are at a great Diſtance from each other's, may have only an equal Sum of Attraction and Repulſion with five Spherules, whoſe Centers are at a ſmall Diſtance from each other: for ſince the Attraction is in a *Ratio* of the Diſtance of each Particle's Center from each other; it being at any Diſtance whatever always, as the Sphere divided by the Square, or more, of the Diſtance, that is,

$$A = \frac{S}{D^2} \text{ or } 40 = \frac{64000 = 40 \times 40 \times 40}{1600 = 40 \times 40.}$$

20 Particles, each of which has but two Degrees of Attraction, by reaſon of a leſs Compreſſion, may equal 5

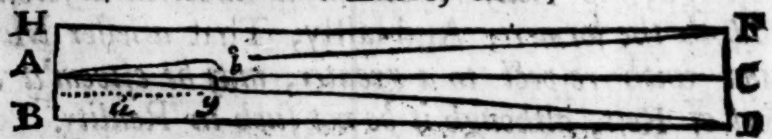
5 Particles each of which has 8 Degrees of Attraction, by Reaſon of a nearer Approach to each other; for in the former Caſe, there is a Rarefaction, in the latter a Compreſſion; ſo that as the Heat depends on this Attraction, this being every where equal, therefore will *that* alſo be every where equal. *Q. E. D.*

I now come to conſider, whether a *Fluid* can be hurried on in the Veſſels by the Force of the Heart, and yet retain an inteſtine Motion, at one and the ſame Time; or in other Terms, whether a Circulation and a Luctation may be compoſſible?

It muſt be remembred, that *equal Moments with contrary directions deſtroy each other:* That *if one Body ſtrikes another at Reſt, or moving the ſame Way, but ſlower, the Motion is continued in the ſame direction; and the Quantity of Motion will be the ſame after the Stroke as before;* That *a Body may be acted upon by a compound Force, that is, a ſecond Force with a different direction, and that ſuch Change is in Proportion to, and follows the directions of that Force; and as the firſt Motion is not deſtroy'd, the Body moves in a direction different to both the former;* And laſtly, That *a leſſer Motion with reſpect to a greater, may be eſteem'd a ſort of Reſt, although it be not ſuch in Reality.*

The Queſtion then is, whether a Body may not be acted upon by compound and ſimilar Forces, which cauſe the Body to move in a new Direction different to either of the former? and whether this be not the Caſe in our Blood?

Let us ſuppoſe the Line of Direction impreſs'd upon the Blood by the Heart, to be denoted by the Letters *AC*; let the Line of Direction of the Motion impreſs'd on the Blood by Luctation be decypher'd by *AB*; and theſe Lines may juſtly enough be imagined to denote the *Circulation* and the *Luctation*, becauſe the Force of the Heart drives the Blood lengthways through the Channels of the Arteries, whilſt by the Motion that produces Heat, half the *Corpuſcles* move in Lines perpendicular to Tangents at the reſpective Section; for as the Blood's Particles are globular, and Twelve equal Spheres can touch one Sphere in the Center of them; as Heat therefore darts around in a ſort of burning Sphere, three of thoſe Globules at Top, and three at Bottom, will dart againſt the Top, and alſo towards the Bottom, along with the Circulation; but the remaining Six will jerk againſt the Sides of the Veſſel towards *AB*, and *AH*; which *lateral motion* is the Direction I ſpeak of; and as this *lateral Motion* is perpendicular to Tangents to that Section; therefore the Angle theſe Motions, to wit, of *Circulation* and *Luctation*, make is a right one. *Eucl. El.* 3. *P.* 31. compleat the Parallelogram from theſe two Lines, thus;



I ſay then, that the Body mov'd with the Forces *AC* and *AB*, will move in the Line *A*D; for neither the Force acting with the Direction *AC*, parallel to *B*D, nor the Force acting with the Direction *AB* paralel to CD, can change their Velocities, towards *AD*, (there being a compound Force impreſſed, and no new Force ſuppoſed to change the Direction, nor any Addition of Force beſides theſe two) wherefore the Body will be carried to *A C*, *A B*, *A D*, or which is all one, to *B D*, *C D*, *A D*, in the ſame Time; becauſe as the Time of Deſcription in *A B*, *A C*, *A D*, is given, the Spaces muſt be as the Velocities, (they being in a compound *Ratio* of the Time and Velocity) which if double, the Spaces are double; therefore the Body will be carried from *A* to *D* in the ſame Time: (hence *A B* is the leaſt, *A C* the middle, and *A D* the greateſt, Velocity, compounded of *A B* and *A C*, as appears by the *Analyſis* of the Powers of thoſe Lines) wherefore it will be found ſome where in the Lines *A B*, *A C*, being compounded of them; but as in every Parallelogram, the Parallelograms which are about the Diameter are ſimilar both to the whole, and amongſt themſelves, wherefore it will be found in the Interſection, or Diagonal *A D*, (this being the Center of thoſe two Forces, or Point, where they combine); for as the whole and its Parts are equi-angular, their Sides oppoſit to the equal Angles are proportional, that is, as the Force denoted by *A D*; is to the Force denoted by *A B* or *C D*; ſo is the Line *A B* to the Line *A C*: and as the Force *A D* is to the Force *AB* or *CD*; ſo is *AD* to *AB* or *CD*. Put then *G* for Part, or whole, of the Velocity moving *A D*; M. for the Force in *A C*; and *N.* for the Force in *B C* or *C D*; it will ſtand thus,

$$G : M \times N :: AD : AC + AB \,.\ (\text{or} : BD \pm CD)$$

And if the Parallelogram ſhou'd be double and *A C* be its *Axis*, the Body wou'd be carried (if a Fluid,) part to *A D*, part to *A F* or in a double Diagonal.

The Lines of Direction obſerve all along the ſame *Ratio*, which they had to each other at firſt: but the Forces, each impreſſing its own Direction, are combin'd into a new Third; wherefore as Forces are directly proportional to the Fluxions of their Lines of Direction; when *AC* has gone ſo far as $\dot{a}$; *AB* will be gone ſo far, and no farther than $\dot{b}$, (as being the middle Way of each Force's Direction) and $\dot{g}$ will be the Interſection where thoſe Forces combine. Then it will be, that when the Body wou'd be at *C* and *B* it will be at *D*.

and $G : M+N :: \surd^2 : \dot{g}^2 : \surd^2\, \dot{a}^2 + \dot{b}^2$

then

$$\surd^2 : \dot{a}^2 + \dot{b}^2 = \frac{M+N \times \surd^2 : \dot{g}^2}{G}$$

and

$$\surd^2 : \dot{g}^2 = \frac{G \times \surd^2 : \dot{a}^2 + \dot{b}^2}{M+N}$$

Then ſuppoſe $G = 7 . M = 4 . N = 3 . b = 3 . g = 5 . a = 4$. it will ſtand thus, $7 : 4 + 3 :: 5 : 5 ; 5 = \frac{4+3 \times 5}{7} ; 5 = \frac{7 \times 5}{4+3}$

In ſhort the exact Meaſure and Proportion of the Diagonals Force to the combin'd Forces, is well denoted by *Eucl. El.* 1. *Prop.* 47.; for + $AC^2 \times AB^2 = AD^2$; and $\surd^2 : AC^2 \times AB^2 = \surd^2 : AD^2$., as appears by analyſing the Powers; and the Line of Direction equal to the Root of its Power, after the new Force impreſs'd, is well expreſs'd by the Interſection. Theſe Lines are commenſurable in Power, and in the Analyſis of theſe Powers; wherefore the Lines will expreſs theſe Powers and Roots.

The Phyſical Reaſon of all which is, there are two Impulſes of different Degrees of Velocity; the Body cannot move in the Line of Direction of the firſt Impulſe; becauſe the ſecond Impulſe diſturbs it; nor in the Direction of the ſecond Impulſe, becauſe the firſt diverts it; wherefore there muſt neceſſarily be impreſs'd a Line of Direction which is a new one, exactly proportionable to both Impulſes; ſo that when the Body is mov'd ſo much forwards by the firſt Impulſe, it will have mov'd juſt ſo much downwards or upwards by the ſecond; This *Point of Combination* is the Interſection or Diagonal ſpoken of; becauſe when Forces combine in a Point, they run on in a perpendicular Line, which of all others is the ſhorteſt, to the Point which is the middle Way of thoſe Forces.

Let therefore *AC* denote 5000, and *AB* expreſs but 1, (which is too chymerical, as may eaſily be proved); yet *AB* will not be deſtroy'd, unleſs in this Senſe, *That a leſſer Motion in Compariſon to a greater, may be look'd upon as a Sort of Reſt*; for in this Senſe the Expreſſion is allowable; becauſe *Fermentation*, or to ſpeak more properly, *Effervescence*, with reſpect to the progreſſive Motion is inconſiderable and gentle indeed, but not deſtroy'd *Q. E. D.* For as all Forces produce Changes in Motion, according to their Directions and Quantities; ſo $M \times D$ will be equal to the greater, and $m \times d$ to the leſſer, which is not deſtroy'd, but chang'd into another Direction.

We have ſeen then, that *Circulation* and *Luctation* may ſubſiſt at one and the ſame Time, and in one and the ſame Veſſel, according to the Computation of the Laws of Motion; but as ſuch Manner of Reaſoning may not be comprehended by all, I ſhall accommodate my ſelf to this ſuch as take Proofs of this kind entirely upon Truſt; and ſince Facts are the moſt convincing Demonſtrations, the following Experiment will ſhew us, that an Efferveſcence and Circulation are compatible.

Take a Crane of Glaſs, fill it with Oil of Turpentine, ſtop the Hole that it may not run out; immerge this curv'd Tube, (the running End of which muſt be lower than the immers'd End) ſo fill'd into any Veſſel in which the Oils of Turpentine and Vitriol are under a Struggle; let go the Finger which ſtops the Oriſice, the Oil of Turpentine will flow out of the Tube's lower Orifice, and the Fluids under Luctation will firſt aſcend, and then deſcend, and run out alſo; the Heat will be communicated to the Tube (and that equally alike) and the Liquor which flows out of this Crane will continue to efferveſce, till each are fully ſaturated.

What is this Heat, but Luctation, but an Efferveſcence, but an Ebullition? And what is this Aſcent and Deſcent, but a Circulation? Efferveſcence therefore and Circulation are prov'd by ocular Demonſtration to be conſiſtent.

Moreover, it might with Juſtice be inferr'd, *ex abſurdo*, that Heat, ariſing from a Luctation, continues during Life; and that the Circulation therefore does not deſtroy this Efferveſcence;

for Heat being ſynonymous with Efferveſcence or a Colluctation, the Deſtruction of the latter is an Extinction of the former.

Here it might be objected, that if Heat depended upon a Luctation, it would be greateſt where this is the moſt, but it is leaſt where Luctation is greateſt, to wit, in the Extremities. We have demonſtrated this to be falſe, Luctation is every where equal, and Attrition is a Condition of Heat.

However, theſe Gentlemen may object again, *That the Force of the Blood in Circulation is ſuperior to the Moment of the Subtile Particles in the Ratio of* 5000 *to* 1, and one of them adds this Reaſon, *becauſe all Qualities propagated from the Center in right Lines, decreaſe in a duplicate Ratio of the increaſed Diſtance from the ſaid Center.*

This *Herculean* Demonſtration is of the ſame Force with the following, to wit, Cylinders, whoſe Baſes and Altitudes are reciprocally proportional, are equal, becauſe the three Angles of a Triangle are equal to two right ones; or, *Julius Cæſar* built the Tower of *London*, becauſe *Nero* was a wicked Prince; or *Caligula* wiſh'd the *Romans* had but one Neck; wherefore *Amurath* conquer'd *Greece*. Where there is no Connexion, there is no Reaſoning, nor any Concluſion to be drawn. And this is all the Beauty there can be in this Gentleman's Argument, where all that is ſaid may be true, but not conſequential.

Having Matters of this Nature under Conſideration, I am unwilling to diſmiſs the Subject, till I have added ſome Speculations concerning the *Magnitude* of the *Pulſe* in high Fevers, and its *Smallneſs* in the Malignant. We conſtantly obſerve the Danger in Fevers to keep Pace with the Exceſs of Dilatation or Contraction of the Arteries, but that it is eaſier to remedy the former by Subſtraction,. than the latter by Addition ; it will be therefore worth our while to take a View of the different Circumſtances the Veſſels and our Fluids muſt be under at ſuch a Seaſon.

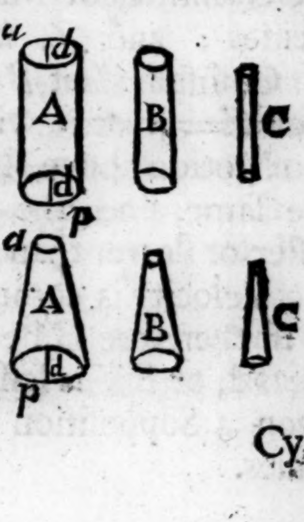
And firſt it is to be obſerved, that in either *Species* of Fevers, the Pulſations increaſe in Numbers to one Third more, at leaſt, than in a natural State ; that is, a natural Pulſe amounts not to above 75 in a given Time, whereas in Fevers of any *Species*, they are augmented to one Third more in Number in the ſame Time, to wit, to 112, nay ſometimes to 120.

Whence it muſt follow, that the *Moments* muſt vaſtly differ in theſe States of Fevers ; for ſince in either *Species* the *Time* and *Celerity* are given, the *Moment* will be as the *Moles*, which if double or quadruple, the *Moment* will be alſo double or quadruple ; Let M, *m* denote the greater and leſſer *Moments* ; *A*, *a* deſcribe the greater or leſſer *Quantity of* Matter ; *T* and C, ſignifying the *Time* and *Celerity*, which are ſuppos'd equal in either ; let $A=6$, $a=2$, $C=3$, $T=1$. then as $\frac{s}{T}=C$; it will be $A\times\frac{s}{T}=AC=M=18$; and alſo $a\times\frac{s}{T}=aC=m=6$; hence it appears, that in the preſent Suppoſition, the *Moment* in a *malignant Fever* will be but one Third of the *Moment* in *High Fevers*.

What theſe *Moments* are will appear anon ; to wit, a greater *Dilatation* of the Veſſels, a Loſs of *Elaſticity* in the Arteries, and ſuch like.

How the *Moles* varies in the different Species, will plainly appear from the following Computations, to wit, it is known, that Cylinders of equal Altitudes, are to each other in a Ratio of their Baſes; that Cones of equal Altitudes, are alſo to each other in a Ratio of their Baſes; that Cones and Cylinders are to each other (when their Baſes and Altitudes are not given) in a compound Ratio of their Baſes and Altitudes; that Cones which have equal Baſes and Altitudes with Cylinders, are one Third of ſuch Cylinders; and Laſtly, it is known, that our Arteries and Veins are partly Cylindrical, partly Conical.

Let then three Cylinders, and as many Cones be ſuppoſed of equal Altitudes, but of different Baſes, according to the different States of our Blood; let *A*, *B*, *C*, denote the Cylinders and Cones of the different States of Blood, to wit, *A*, the increas'd Artery, *B*, the natural, and *C*, the decreaſed Veſſel; then let *d* denote the Diameter of the Baſe, *p*, the Circumference, *a*, the Altitude, which is given in them all; then in the Cylinders $\frac{dp}{4} \times a =$ Quantity of Matter contain'd; and $\frac{dp}{4} \times \frac{a}{3} =$ *Cones Contents.* let $a = 4$ Yds.; d. in A be $= 6$, in $B = 4$, in $C = 2$; let p in $A = 18$; in $B = 12$; in $C = 6$. then the Contents in the



Cylinder *A* will be 108; in *B*, 48; in *C*, 12; in this Suppoſition, the Contents of *C* will only be $\frac{1}{9}$ Part of *A*, and but $\frac{1}{4}$ Part of *B*. And the Contents of the Cone *A* will be 36; the Cone *B*, 16; and $C=4$; then *C* will be $\frac{1}{9}$ of *A*; and $\frac{1}{4}$ of *B*; The Height I have only ſuppos'd, for the Length of our Veſſels is a *mean Arithmetick Proportional* between the longeſt and ſhorteſt Artery, as Dr. *Cheyne* obſerves, ſince $L=s \times l$; *L* being equal to the middle Term doubled.

Having by theſe Meaſures obtain'd the Proportions of the Quantity of Blood there is in each Cylinder and Cone; our next Enquiry ſhould be into the *Velocity* in either State; but as this is given in either, the *Moments* of Circulation will be as the *Quantities of Matter*; which if double or quadruple, the *moments* will be, as has been ſaid, double or quadruple.

Theſe Computations would be juſt, if there were no Reſiſtance made to the Circulation; but as theſe Fluids move on in the ſame Direction, it will be $\frac{BV \times bv}{B \times b}=Z$. Putting *B* and *b* for the Quantities of Matter, and *V*, *v*, for the Velocities; and *Z*, for the common *Velocity* after Colliſion: Let $B=36$, $V=3$; $b=16$; $v=3$; then $Z=3$. or it will be equal to the Exceſs of the Motion above the Reſiſtance; for *V* and *v* is the ſame, ſince the Body impelled cannot move faſter or ſlower than it is impelled, and therefore the Velocity is common.

If therefore *B* be diminiſhed, either *V* is increas'd, or *BV* is leſſen'd, or *bv* is increas'd; this upon a Suppoſition that the ſame Moment continues.

If V is increaſed, either bv is leſſened, or BV is increas'd, or B is diminiſhed.

In the High Fevers therefore, either the Power of the Heart is augmented, or the Reſiſtance is diminiſhed; for the Velocity being given in both, Nothing diſtinguiſhes the Power or Reſiſtance ſave this Quantity; B therefore or b being augmented by any ſuppoſed or determin'd *Ratio*, the Power or Reſiſtance muſt be proportionably augmented or diminiſh'd, as will appear to the leaſt knowing in the Laws of Motion. If B then be only equal to 36, and $b = 16$; then 16 $\frac{BV \times bv}{B \times b} = Z$; then the Blood will of courſe ſtagnate, becauſe the Reſiſtance will be ſuperior to the Heart's Power, by ſo much as in the former Suppoſition, the Heart's Power was ſuperior to the Blood's Reſiſtance: For ſince $p : r :: n : m$: putting p. for the Power, r. for the Reſiſtance, n. for the Velocity of r, and m. for the Velocity of p. as is uſually done; if $pm = rn$, there would be an *Æquilibrium*, and conſequently there would be no Motion, ſince there wou'd be a *Ratio* of Equality between the Power and Reſiſtance, till $pm > rn$, or till $\frac{r}{p} > \frac{m}{n}$, for then it is that the Power of the Heart would be ſuperior, as in the firſt Suppoſition: Thus may it be computed, how much a *given Force may move a given Weight*, and conſequently, how much the Heart's Power may or does conquer the Reſiſtance to Motion in the Arteries.

Thus if the Sum of any Motion towards the ſame Part, continues the ſame or is not chang'd;

if BV be called a, and bv be called e; and $a—e$, be called d, the Difference of Motion; $a=\frac{s\times d}{2}$ and $e=\frac{s—d}{2}$ and $d=a—e$, that $a=\frac{36+16+20=72}{2}=36=\frac{BV+bv+D}{2}$; $e=\frac{BV+bv—D}{2}=36+16—20=32\div2=16$; and $a—e=D=20$.; then as V is common to both, B of a muſt be diminiſhed, or b of e muſt be increas'd, or there muſt be no Alteration in d to have the Sum continue the ſame.

Wherefore, in High Fevers, the Pulſe's Numbers being equal to thoſe in the Low and Malignant; it muſt follow, that in them the Power of the Heart is ſuperior to the Reſiſtances in the Blood and Veſſels, and that therefore the firſt Mover muſt be more copious; and in Truth, the Quantity of Spirits, the Fluidity of our Blood, and the Flexility of the Veſſels, make our Pulſe ſtronger than naturally it is; whereas, *vice verſâ*, the Want of Spirits, the Coheſion of our Fluids, and Rigidity of the Veſſels in malignant ones, make the Pulſe weaker.

From all which Conſiderations, it appears, why in *malignant Fevers*, Coheſions, Stagnations, *Petechiæ*, and other Symptoms ariſing from a diminiſhed Quantity of Motion ſhould befal Perſons ſeized with them: On the other Hand, in *High Fevers*, where the Pulſe is larger, the Conſequences muſt be too great a Dilatation of the Veſſels, Breaches, and Effuſions of the Contents into divers Cavities, or a total Abolition of their reſtitutive Force, which will neceſſarily be attended with the ſame Symptoms as the Malignant introduces. This Abolition appears too plainly in Perſons, who from a Puſillanimity, or any other Cauſe, have retain'd their Urine too long; for the Coats of the Bladder cannot contract themſelves, becauſe the ſuper-abundant Load by compreſſing the Fibres, keeps the Spirits out, and the Muſcular Fibres loſe their Force. This Caſe of too great a Dilatation of the Veſſels is very evident to Practitioners in the Fevers commonly reigning near or under the Line, where unleſs *due* Evacuation be made very *haſtily*, the Perſons ſo ſeiz'd die in two Days. That the Arteries are elaſtick, appears from their *Syſtole* and *Diaſtole* continued during Life; however it is evident, that this *Spring* of the Veſſels has certain Limits, beyond which if it be ſtretched, they loſe it, and then it becomes very often irrecoverable. It is a conſtant Obſervation, that *if Elaſtick Fibres be extended with too much force, they loſe their Elaſticity*; nor can it be aſſign'd how far ſuch Fibres may be extended, before they will loſe their Force; ſince in ſome Individuals the Elongations or Dilatations may be infinitely increas'd before they loſe this Tone, whereas in others, it is deſtroyed with half the Tenſion.

As Coheſions are the Conſequence of the Manner of Circulation in Malignant Caſes, the Spirits in ſuch Circumſtances will be few, and inſufficient for the Buſineſs of Life, the Heart will not be capable to drive its Contents forwards, and a Want of Spirits introduces a Train of bad Symptoms,

toms, which uſher in Death: For the Quantity of Spirits ſeparated are directly as the Blood's Velocity, but inverſely as its Coheſion, which is directly as the Evaporation of the more humid Parts, or as the Quantity of *Tartareous* Parts or other Impediments in the Blood.

Theſe Coheſions will better appear to View, if we compute the Difference of Compreſſion in the malignant and high Fevers; becauſe then we ſhall be appriz'd of the different Denſities of the ſame Fluid (abſtracting from Effuſions) in the reſpective Caſes: For ſince the Spaces occupied muſt be reciprocally as the Forces which compreſs them; the different *Moles* of the ſame Matter will denote the Forces compreſſing, putting the Effects in the Place of the Cauſes; then put $F =$ greater Force, $f =$ leſſer Force; S, s, equal to the greater and leſſer Space; the Forces will be reciprocally in a *ſeſcuplicate Ratio* of the Spaces, and $F : f :: S : s$; then $s = \frac{fS}{F}$ *and* $S = \frac{Fs}{f}$

Or,

If for F we put $\frac{DP}{4} \times A$; or $\frac{RD^3}{4}$; for f put $\frac{dp}{4} \times a$ or $\frac{rd^3}{4}$; for S put $\frac{DP}{4}$ or RD^2; for s, put $\frac{dp}{4}$ or $r d 2$; then it will be

$$\frac{DP}{4} \times A : \frac{dp}{4} \times a :: \frac{DP}{4} : \frac{dp}{4}$$

Or,

$$\frac{RD^3}{4} : \frac{rd^3}{4} :: RD^2 : rd^2.$$

or 108 : 12 :: 27 : 3.

dividing therefore 27 by 3, it will appear that the ſame Quantity of Blood in the latter Suppoſition, where it is much compreſſed, without being extravaſed, will only occupy $\frac{1}{9}$ Part of the Space it does in the former Caſe; and that therefore the Blood in a malignant Fever has leſs Bulk under the ſame Quantity of Matter, or is ſo compreſſed, that it will be nearly reduc'd to the Conſiſtence of a ſolid Body; whence it won't yield, as a Fluid ſhould do by its Nature, to the Impreſſion given it by the Heart; that is, from a Fluid it becomes a Solid, and coheres ſo ſtrongly, that the Circulation muſt inevitably ceaſe; for ſince the *Denſity in homogeneous Bodies is inverſely as their Bulk*, the denſer a Body grows, the more it approaches to a Solid, the Attraction in the preſent Caſe being ſuperior to the repellent Force; wherefore let the Abſolute Gravity be given, for which put *A*, the Denſity will be inverſely as the Magnitude, put *D*, *d*, for the greater and leſſer Denſity; and put M, *m*, for the greater and leſſer Magnitude; it will appear that the Denſity of the Blood thus compreſſed to the preternatural Expanſion of it in high Fevers, will be *quam proximè* as 10 to 1. For *A*, ſuppoſe 60 Grains, for *D* put 10; for M put 60, for *d* put 1, for *m*, 6; then $\frac{A}{D}=M$; $\frac{A}{d}=M$; and $\frac{A}{m}=D$, and $\frac{A}{M}=d$; that is, $\frac{60}{10}=6$; $\frac{60}{1}=60$; and $\frac{60}{6}=10$; and $\frac{60}{60}=1$; from whence it appears that the Blood in a high Fever is but $\frac{1}{10}$th of the Denſity of that in a malignant one, and that therefore it is nearly as much coagulated in the Veſſels in a malignant Fever, as it is when let out into the Diſh. *Q. E. D.*

There ſeems yet to remain a Difficulty concerning the Nature of the Reſiſtance made to the Blood's Motion in malignant Fevers ; which I ſhall endeavour to diſcuſs. We feel the Artery in ſuch Caſes, under our Fingers, much reſembling *a hard and ſmall Chord* ; we have ſeen what this Smallneſs denotes, it now remains to aſſign ſome Cauſe for this *Hardneſs* and *Smallneſs* ; but as that cannot be done without taking a View of the Structure of an Artery ; the Readers will be pleaſed to pardon that neceſſary Digreſſion.

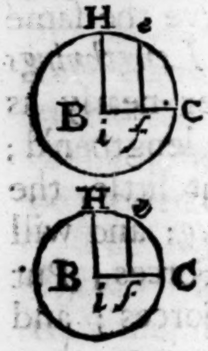
The Arteries are called μυῶνες συριγγώδεες, or *Fiſtular Muſcles*; becauſe like Muſcles they contract themſelves, and becauſe ſome of their Coats are tendinous : But the Ancients were ſo unhappy as not to underſtand their Uſe, neither were they appriz'd of their true Structure. An Artery then has five Coats, *the Exterior is nervous*, and the little nervous Fibrils are very plainly diſcoverable to the naked Eye ; as the nervous Twigs creep round them, and are beſtow'd on the Arteries from the *Par octavum* and *Vagum*, ſo the *exterior Surface* of the Arteries, which we feel upon all Occaſions, is intirely nervous. The next Coat is *Vaſcular*, and conſiſts of Arteries and Veins, plainly diſcoverable by Injection, and is at preſent called by the Name of *Vaſa Vaſorum* ; the third Coat is *Glandular*, which ſpues into the innermoſt Coat an oily Fluid, which lubricates it, and keeps it ſupple and elaſtick ; the fourth Coat is *Muſcular*, and the fifth or innermoſt is *membranous*.

Having deſcrib'd the Structure of an Artery, let us proceed to give Reaſons, why they are hard and ſmall in malignant Fevers *Nerves* are the *Meninges* of the Brain ſpun out into ſmall *Cylinders*; and as the Structure of the *Meninges* is membranous, that is, they are a *Faſciculus* of Fibres variouſly interwoven, ſuch alſo muſt the Nerves be.

Since the *Nerves* therefore are Fibres, their *Lengthnings* and *Shortnings* will obſerve the ſame Laws as other Fibres do : But the *Lengthnings* of the ſame Fibres are to one another nearly as the Forces, by which the Fibres are lengthen'd; therefore where the Force varies but little, the Lengthnings will keep the ſame *Ratio*; and will be greater or leſs, according to theſe Forces; Put then F, f, for the greater and leſſer Forces; and L, l, for the greater and leſſer Lengthnings; then it will be that the Lengthnings are in a ſubſeſcuplicate Ratio of the Forces.

$F : f :: L : l$., then $L = \frac{Fl}{f}$ and $l = \frac{fL}{F}$

Let $F=6$; $f=3$; $L=3$.; then $6 : 3 :: 2 : 1$; $l=1$. and $L = \frac{6\times 1}{3} = 2$. Now in Circles, the tranſverſe Sections, or the Peripheries differ as do the *Radii*; where thoſe are in a *Ratio* of theſe, that is, the Peripheries of Circles are to each other as the Squares of their Diameters, *Eucl. El.* 12. *Prop.* 2. Whence it follows, that the Lengthnings of Fibres which run *ſpirally*, are to be meaſured by theſe *Peripheries*, or theſe Diameters; and as the Peripheries of the Arteries increaſe or decreaſe, ſo are the Nerves, which creep along their outward Surfaces, lengthen'd or ſhorten'd: But in Circles, the Fluxions of Arches are reciprocally as their reſpective Ordinates ; whence it is, that the greater is the *Radius*, the greater is the Circle, and *vice verſâ*; put $\dot{c}$ for *Ch* or *ce*; x. for *Cf*; r. for *BC*; y. for *ef*; f, for *Ch*; $\dot{v}$ *for Ci*; z. for *hi*; then ſuppoſe $\dot{c}$ at *ch* to be c; and $\dot{x}$ at *CB* to be x; $\dot{v}$ and f at *ch* and *ci*, to be f and v.



$$\dot{c} : \dot{x} :: r : y. \quad \Big| \text{ and } \dot{f} : v :: r : \dot{Z}$$

$$y = \frac{xr}{c} \quad \Big| \quad \dot{x} = \frac{cy}{r} \quad \Big| \quad z = \frac{\dot{v}r}{f} \quad \Big| \quad \dot{v} = \frac{\dot{f}z}{r}$$

$$\dot{c} = \frac{\dot{x}r}{y} \quad \Big| \quad r = \frac{cy}{\dot{x}} \quad \Big| \quad \dot{f} = \frac{\dot{v}r}{z} \quad \Big| \quad r = \frac{\dot{f}z}{\dot{v}}$$

or, if we take c and d for the ſtated Proportion between the Circumference and the Diameter of the Circle, (whether by *Archimides*'s, *Metius*'s, *van Ceulen*'s, *Vieta*'s, *Snellius*'s, *Lansbergius*'s, or Sir *Iſaac Newton*'s Method,) and C and D for the Circumference and Diameter ſought, then we may ſay, $c:d :: C:\frac{dC}{c} = D$. then $C = \frac{cD}{d}$;

Having by either Method found the Circumference or Diameter, the other is eaſily found; but as in feeling an Artery, Phyſicians only touch one Quarter of the whole; we muſt multiply that Quarter by 4, in order to obtain the whole Periphery.

If then we compute the Lengthenings by the Peripheries of the reſpective Circles, they are in a duplicate *Ratio* of their reſpective Diameters; but if by the Diameters, then they are ſubduplicate of their reſpective Peripheries, So that continuing the Proportions above-named in *Cylinders* and *Cones*, $\frac{dp}{4}$ in the firſt will be equal to 27; and in the latter to 12; and the Lengthening will be as $2\frac{1}{4}$ to 1.

Having thus found theſe Proportions, the Lengthnings of the Nerves ſurrounding the Arteries in *high Fevers* are alſo found; as are their Shortnings in the malignant *Species*; it muſt then be neceſſarily granted, that the Nerves are contracted in malignant caſes, becauſe they are every where in the ſame State, ſince the Diſorder is univerſal. And as Bodies contracted contain more Matter under a leſs Bulk or Space; it follows, that the cloſer and more compact the Nerves grow, the harder they will feel to the Touch, becauſe *Hardneſs* is defined to be a *mutual Coheſion of the Parts of a Body, which do not yield inwards, nor are ſubject to any* Motion *in reſpect to each other, without breaking the Body*; hence will the Nerves feel hard, hence will they not yield to the Blood extruding the Arteries, and they will nearly loſe their Elaſticity.

It muſt then be concluded, that our Arteries do therefore feel hard and ſmall in malignant Fevers, becauſe our Nerves are contracted, hard, and non-elaſtick: For as *theſe* ſurround the Arteries, they can be no more dilated than the reſiſting Nerves will permit them; as therefore it has been already obſerved, that either the Reſiſtance ($b\ v$) is increas'd, or the Power

(*BV*) is diminiſhed : and alſo the Reſiſtance is increas'd ; this Reſiſtance ſo little obſerv'd hitherto is the *Contraction of this nervous Coat of the Arteries.* If Juices are not ſupplied to Bodies accuſtomed to be duly nouriſhed, their Parts become cloſer, and Bodies grow harder ; and whatever *contractile Syphon* is reſtrained by ſuch a Force, it muſt obey, becauſe it is a Force truly ſuperior, and cannot admit of a greater Dilatation, than it hath. Therefore do the Arteries feel ſmall and hard to our Touch, by reaſon this Contraction is ſtrong and ſuperior to the Propulſive Power of the Heart. *Q. E. D.*

I do not enquire into the Cauſes which introduce this State of the Nerves, to wit, whether it proceeds from a Loſs of Spirits, from an Evaporation of the Parts which keep the Nerves ſupple, from a certain Combination of Salts, which hinder the Secretion of the Spirits, from a Viſcoſity in the *Liquidum Nervorum*, or from what other *prior* Cauſe whatever, becauſe it is impertinent to the preſent Caſe.

It follows from hence, that as the Circulation is perform'd by Means of the *Syſtole* and *Diaſtole*, and as the Reſtitution is equal to the *Dilatation*, in a natural and a high preternatural Circulation, the Artery recedes from, and accedes to its Center or *Axis* in a much greater Proportion, than it does in malignant Caſes ; ſince in theſe elaſtick Canals the Fibres return to the ſame Length inwards beyond their natural Bent, as they ſwerv'd from it outwards : In ſuch a Caſe, therefore, the Wall of the Arteries, more eſpecially in high Fevers, will approach very near to

(*BV*)

a Contact; and therefore the Blood in ſuch a Suppoſition, will be driven on violently thro' its Channels; and *vice verſâ*, as in malignant Caſes this *Receſs* and *Acceſs* of the Arteries is infinitely ſmall, the Blood muſt be weakly propelled.

Since the *Blood* in the *low Malignants* is under a State of Compreſſion, and does thereby become denſe, and as this State augments the Coheſion, by reaſon of the Loſs of the *reſilient Force* in the Blood, for we know that Bodies the moſt elaſtick may loſe and regain that Property, as certain Limits are exceeded, or recovered; I beg Leave to make a ſmall Excurſion before I finiſh theſe Inquiries, into the Methods by which this State may be overcome; I conceive this may be effected by *Attraction*, by the Force of *Gravity*, or by *Both join'd*, as Experience daily informs us, and by *Stimuli*: but they being an Artifice made uſe of to return the Elaſticityof the Fibres nearly loſt, and being *externally practiſed*, I ſhall omit any further Notice of them here, and ſhall only ſpeak of the internal Meaſures.

The laſt component Parts of Fluids are by all juſtly ſuppos'd *globular*, for that Figure, which *at one and the ſame time* can move quickly and ſlowly, can move without changing Place, which will at once move upwards and downwards, which has infinite Balances, and all poſſible Inclinations, according to its various Diameters, which moreover has the greateſt Conformity, Proportion, and Similitnde in it beyond any other Figure, and which, *in fine*, enjoys ſo many contrary Properties at once, muſt be the moſt convenient of all other

Figures for Motion; and as its Contact is only punctual, it muſt touch in fewer Points than any other Figure whatever, ſo that poliſhed Spheres will be eaſily mov'd; when any *Medium* interpoſes to fill up the void Spaces, if the Sphere's Circumference were conceiv'd, to conſiſt of 30 Points, the latter Contact would be to the former, as 10 to 1.

Now Coheſion increaſes with the Contact, which therefore in the preſent Suppoſition will be as 10 to 1. And to deſtroy *this*, we muſt overcome *that*, which I ſhall ſhew briefly how to compaſs.

I have ſaid that *Attraction* is one Method, whereby Coheſion is overcome; whatever the cauſe of this Property may be, I do not take upon me to decide here, however I mean by it a certain Power whereby one Medicine alters the predominant Qualities of another; and ſince *Attraction* is inverſely as the Diſtance, and directly as the Quantity of Matter, it muſt follow, that ſuch attracting Medicines as have the leaſt Bulk under the ſame Matter, are the ſtrongeſt; and that only ſuch Particles as are under Contact, or very near it, do attract; from hence it appears, why volatile Spirits pour'd into a ſmall cylindrical Tube, in which *Serum* has been thicken'd by acid Spirits, will only attenuate a very thin Surface of that gentle *Coagulum* by its attractive Power; from hence it may be inferred, that the Alteration made in our Fluids by the Power of Attraction only would be ſlow.

When Medicines act by their Gravity, the Moment will increaſe in a *Ratio* compounded of this Gravity wherewith they are hurried on, as all do know. And as Reſiſtance is a Re-action, its Moment alſo is computed in the ſame manner. But as Reſiſtance is double, I would in the preſent Snppoſition be underſtood only to comprehend *that* which proceeds from the *Inactivity of Matter* : for the Reſiſtance from *Coheſion* is of another Nature, nor have we perhaps attain'd to the true Method of computing it hitherto. By the Meaſures I uſed to come at the Degree of Coheſion in *Serum*, I found by ſeveral Trials, that the Body would run the ſame Space (with the ſame Number of Grains) in natural *Serum* to what it did in *Serum* thicken'd by *Acid* Spirits, in half the Time ; whence it appears, that the Velocity in coagulated *Serum* was in a *Subduple Ratio* to the Velocity in natural *Serum* : For the Space given, the Velocity is inverſely as the Time : But the Coheſion is directly as the Time : Wherefore the Velocity is inverſely as the Coheſion, where the Retardation denotes the Coheſion.

Reſiſtance then to Motion is always as the Diameter of the moving Body ; and the Retardation is inverſely as its Denſity : whence it follows, that the denſer are Bodies, the leſs are they retarded ; and the greater *Moles* they have, under a certain Denſity, the more are they reſiſted in their Motion ; whence it appears, that if two Bodies, whoſe Denſities are different, be equal, they will be equally reſiſted, but the denſer Body will be leſs retarded, and conſequently will run over the greateſt Space in an equal Time ; whence it follows, that Mercurials, for Example, break Coheſions quicker and more efficaciouſly than volatile Spirits do; becauſe, ſuppoſing their Velocities and Weights equal, yet becauſe Mercurials ſuffer leſs Reſiſtance, and are alſo leſs retarded, they will break the Coheſion in a leſs Time; for, as the *Pondera* are given, in Mercurials, the Retardation will be little, becauſe the Denſity is great, and the Reſiſtance will be ſmall, becauſe their Diameters are minute; ſo that if we put *D* for the Diameter, *H* for the Height, and *R* for the Reſiſtance; it will be $D \times \frac{H}{2} = R$; that is, the Reſiſtance will be equal to the Diameter of the Sphere multiplied into half the Height, generating the Velocity with which the Body is moved. Now the larger is the Diameter, the greater is the Weight of the liquid equal to the Diameter of the Body, and the greater its Height alſo, and conſequently the greater will be the Reſiſtance; this Reſiſtance found, which ſuppoſe equal to 30; muſt be divided by the Weight of the Body equal to 15 in Mercury, but to 1 in Spirits of Hart's-Horn, you have the Retardation, as 2 to 30; that is, Spirit of Hart's-Horn will be fifteen times more retarded than Mercury; and therefore cannot penetrate deep into the Blood by an Equal Force, as Mercury does. In Fact, Experiments ſhew, that Mercurials do break the Coheſions of any Degree effectually and quickly, which volatile Spirits did not, and therefore attracting Medicines which act barely as ſuch, are ſlow in their Operation; nay, *Serum* coagulated by Heat, whoſe Coheſion was found to be to natural *Serum* above 2400 to 1, was effectually broken by Mercury toſs'd with a Parcel of it in the ſmall cylindrical Tube ſpoken of above. Whence it ſeems to be a prudent Management to co-adminiſter Medicines acting by the Force of Gravity along with attractive ones, as many Authors, among whom is *Dolæus*, *p.* 597, adviſe; becauſe the former make way for the latter; the former acting only by their Gravity, do not indeed, as the latter, take off the Opacity of the Fluid; becauſe they do not precipitate the *Medium* of a different Denſity out of the Pores of the Fluid, as the latter do; however, they are frequently uſed in Fevers, (whether Intermitting, Remitting, Continual Peſtilential, and even in the *Peſtis* it ſelf,) where the Blood is found to cohere dangerouſly, ſuch are *Cinnabaris Nativa*, or *Antimonii*, *Antimonium* Diaphoreticum, *Bezoartica minerale*, *Solare*, *Lunare*, *Joviale*, *Arcanum duplicatum cum Cinnabari nativâ*, or *cum Mercurio dulci*; *Aurum Moſaicum*, and ſuch like; whence they who have conceived Prejudices againſt theſe or ſuch Medicines, becauſe they don't find them to efferveſce with Fluids poured upon them, do err againſt Reaſon and Experience.

What Light theſe Enquiries will give to Practice, is eaſy to determine; becauſe they are founded upon Facts in the reſpective caſes mentioned; for as Phyſicians are under a Neceſſity to have Recourſe to ſome one Theory, whereby to explain the *Phænomena* in human Bodies; (let them pretend to decry it with all their Wit and Reaſon, as much as they pleaſe, in order to favour Experience) they ought not to make Facts ſubmit to Theory; but on the contrary, they ſhould be ſure by repeated Experience, that ſuch *Phœnomena* are regular, ſtated, and conſtant, before they begin to reaſon on them; and that Theory which agrees to this Experience in every Particular, is, at leaſt the moſt probable, if not certain. Thoſe very Phyſicians who have ſeemed to ſpurn at any Reaſoning in Phyſick, have even begg'd the Queſtion more than their Brethren who were Sticklers for it. Dr. *Sydenham* very expreſsly damns all Speculation in Phyſick, whilſt it may fairly be proved upon him, that no one practiſes it more, as if his Deſign were only to make uſe of a *Paraleipſis* in his Diſcourſe, what other is his *Ebullition*, his *Deſpumation*, his *Imbecility of Spirits*, his *impair'd Digeſtion*, his *debilitated Craſis*, and ſuch like.

Theory then is neceſſary, but only ſuch as ſuppoſes Facts, only ſuch as waits upon the Back of Experience, ſuch *in fine* as feigns Nothing, ſuch as is drawn *a poſteriori*, ſuch as does not contradict Experience, but agrees with it, and ſubmits ſo religiouſly to it in every Particular, as to make it the Touchſtone, whereby to try its Truth. Such Theory I embrace only, and abhor any other.

FINIS.

Errata. P. 9. 23. after *V*. read V : *a* (or *v* 1); P. 24. l. 32. read *determinate*. p. 27. l. 15. r. *in* 12 *Points*. p. 36. l. 16. for *firm* r. *fluid*. p. 37. l. laſt, r. *more than* double. p. 45. l. 31. r. $M+N$. p. 46. l. laſt but three, r. $AC\,2 + AB2$ r. V: $AC2 + AB2$.; p. 48. l. 6. for *this*, r. *ſuch*.

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